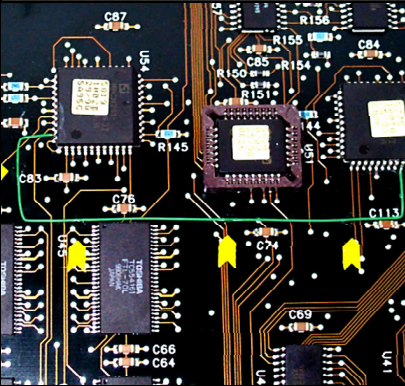


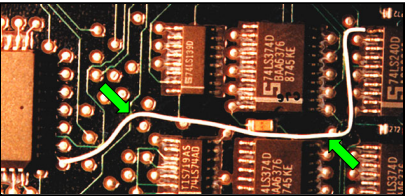
DISCRETE WIRING
JUMPER WIRES



JUMPER WIRES

Jumper wires (a.k.a.: haywires) are used to facilitate minor circuit modifications to printed wiring assemblies (PWA), rather than redesign and manufacture a new board. While their use is an accepted practice, the customer must grant approval prior to their use and installation.

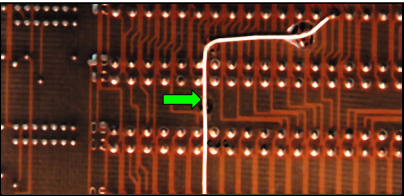
Jumper wires are usually solid, insulated copper conductor with tin/lead plating (i.e.: wire wrap wire), although jumpers less than 25mm (0.984 in.) may be uninsulated, provided the jumper is not liable to short between lands or component leads. Silver-plated and/or stranded wire shall not be used.



PREFERRED COMPONENT TERMINATION SIDE

Wire route is the shortest path. Wire does not pass over or under components, or pass over any land or via used as a test point. Sufficient slack to allow relocation during component replacement.

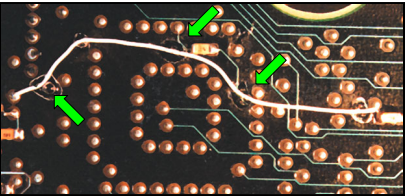
[Best Workmanship Practice](#)



PREFERRED SOLDER TERMINATION SIDE

Wire route is the shortest path. Wire does not cross component footprints or lands, except where unavoidable. Wire does not pass over any land or via used as a test point.

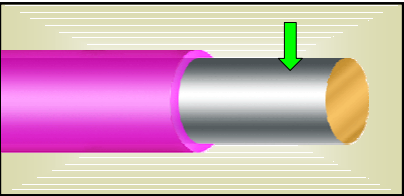
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MANDATORY STAKING

Jumper wire is staked at intervals specified by engineering documentation. The wire is staked at all changes of direction to restrict movement, and as close to the solder termination as possible.

[NASA-STD-8739.1 \[9.2.4 \]](#)

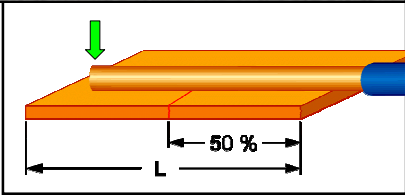
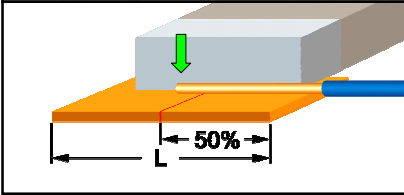


MANDATORY SOLID, INSULATED CONDUCTOR

Jumper wires shall be solid, insulated copper conductor with tin/lead plating (i.e.: wire wrap wire). Stranded, silver-plated wire shall not be used.

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DISCRETE WIRING
JUMPER WIRES (cont.)



ACCEPTABLE LAP TERMINATION, SMT (MINIMUM)

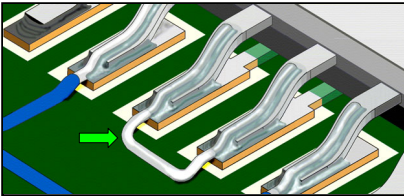
The jumper wire termination shall be parallel to the longest dimension of the pad, with the solder fillet $\geq 50\%$ of the land width (L).

[Best Workmanship Practice](#)

ACCEPTABLE LAP TERMINATION - VACANT LAND / PAD

The jumper wire termination shall be parallel to the longest dimension of the pad (L), shall be a minimum of 50% of the dimension (L), and shall not overhang the pad.

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ACCEPTABLE UNINSULATED WIRE

Uninsulated jumper wires shall be less than 25mm (0.984 in.) long, and shall not violate minimum electrical spacing requirements. Silver-plated, stranded wire shall not be used.

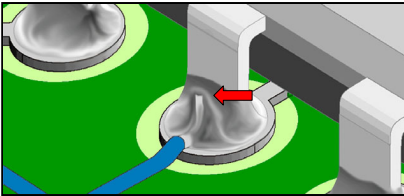
[Best Workmanship Practice](#)



ACCEPTABLE VIA TERMINATION

Jumper wires may be terminated and soldered into a via hole.

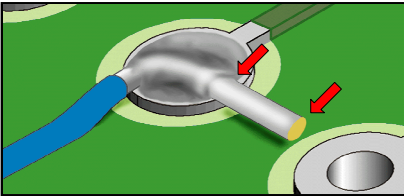
[Best Workmanship Practice](#)



UNACCEPTABLE IMPROPER LAP TERMINATION, PTH

The lap joint is less than the required 75% of the lead length.

[Best Workmanship Practice](#)

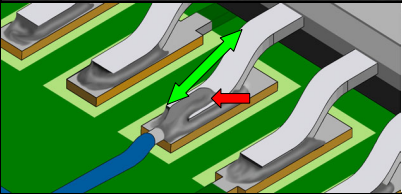


UNACCEPTABLE IMPROPER LAP TERMINATION

The lap termination shall not overhang the land and/or violate minimum electrical spacing.

[Best Workmanship Practice](#)

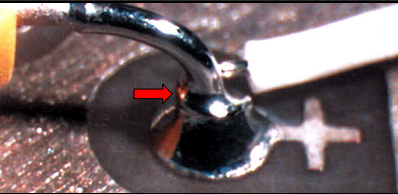
**DISCRETE WIRING
JUMPER WIRES (cont.)**



**UNACCEPTABLE
IMPROPER LAP TERMINATION
GULL WING SMT**

The jumper wire termination shall be a minimum of 75% of the lead length (L), as measured between the toe and knee.

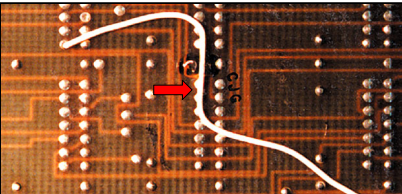
[Best Workmanship Practice](#)



**UNACCEPTABLE
IMPROPER LEAD TERMINATION**

The termination wrap shall be a minimum of 90° and a maximum of 180°, with evidence of proper insulation gap, and without overhanging the component termination.

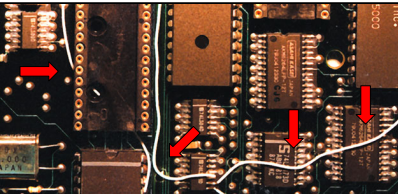
[Best Workmanship Practice](#)



**UNACCEPTABLE
IMPROPER ROUTING
(OVER TEST POINTS)**

Jumper wires shall not be routed over circuit patterns or vias that are used as test points.

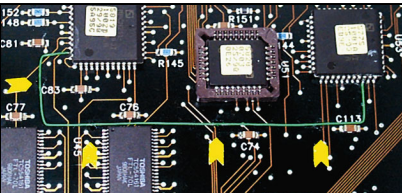
[Best Workmanship Practice](#)



**UNACCEPTABLE
IMPROPER ROUTING
(OVER / UNDER COMPONENTS)**

Jumper wires shall not be routed over or under components.

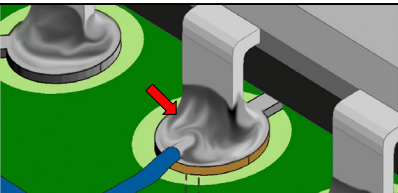
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**UNACCEPTABLE
IMPROPER STAKING**

The jumper wire is not staked as specified. The wire is loose and can extend above the height of adjacent components.


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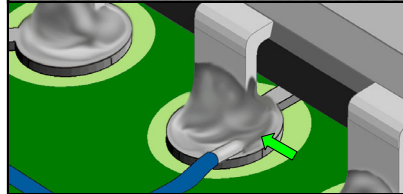
**UNACCEPTABLE
IMPROPER TERMINATION
(OCCUPIED PTH)**

Jumper wires shall not be terminated and soldered into plated-through holes (PTH) occupied by a component lead.

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NASA WORKMANSHIP STANDARDS			
 <p>NATIONAL AERONAUTICS AND SPACE ADMINISTRATION</p> <p>JOHNSON SPACE CENTER HOUSTON, TEXAS USA 77058</p>	Released: 03.30.2001	Revision:	Initials:
	Book: 3	Section: 3.02	Page: 4

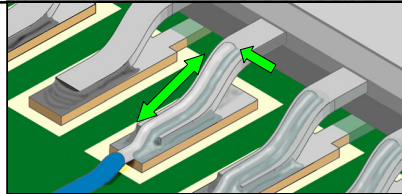
**DISCRETE WIRING
JUMPER WIRES (cont.)**



**ACCEPTABLE
COMPONENT LEAD TERMINATION**

The termination shall be wrapped a minimum of 90°, exhibit proper insulation clearance, the outline shall be evident in the fillet, and shall not violate minimum electrical spacing.

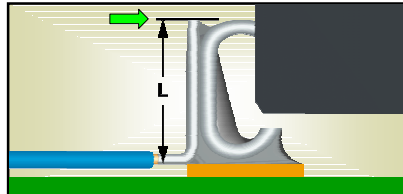
[Best Workmanship Practice](#)



**ACCEPTABLE
LAP TERMINATION, GULL WING SMT**

The jumper wire termination shall be a minimum of 75% of the lead length, as measured between the toe and knee, and shall not extend past the top of the component body.

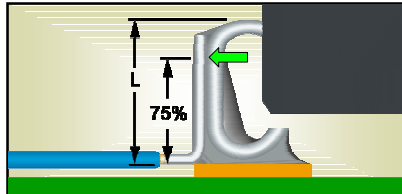
[Best Workmanship Practice](#)



**PREFERRED
LAP TERMINATION, J-LEAD SMT**

The jumper wire termination length shall be equal to the lead height (L), and shall not extend past the top of the component body.

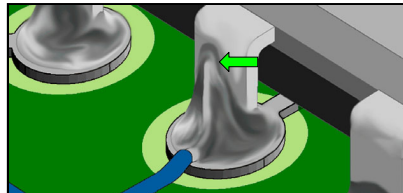
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**ACCEPTABLE
LAP TERMINATION, J-LEAD SMT (MINIMUM)**

The jumper wire termination length shall be a minimum of 75% of the lead height (L), and shall not extend past the top of the component body.

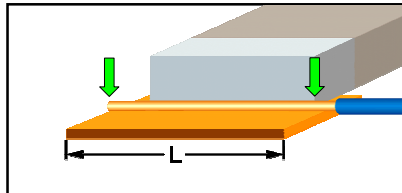
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**ACCEPTABLE
LAP TERMINATION, PTH**

The termination shall exhibit a lap solder joint a minimum of 75% of lead length, proper insulation spacing, a discernable outline, and not violate minimum electrical spacing requirements.


[Best Workmanship Practice](#)



**ACCEPTABLE
LAP TERMINATION, SMT**

The jumper wire termination shall be parallel to the longest dimension of the pad, with the solder fillet equal to the land width (L).

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NASA WORKMANSHIP STANDARDS			
 <p>NATIONAL AERONAUTICS AND SPACE ADMINISTRATION</p> <p>JOHNSON SPACE CENTER HOUSTON, TEXAS USA 77058</p>	Released: 03.30.2001	Revision:	Initials:
	Book: 3	Section: 3.02	Page: 2